Neighborhood Planning for Community Revitalization

Automobile Recycling Alternatives: Why Not?

A Look at the Possibilities for Greener Car Recycling

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Automobile Recycling Alternatives: Why Not?

A Look at the Possibilities for Greener Car Recycling

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SECTION 1: EXECUTIVE SUMMARY

NO SHAMS! (Neighbors Organized to Stop the Hazards of All Metal Shredders!), is a citizens' group based in Saint Paul's West Side neighborhood, along the Mississippi River. The organization was founded in September 1995 by West Side residents concerned about the possibility of a metal shredder being built in their community by a local business, Alter Trading Corporation. Now, in May 1997, NO SHAMS! is still opposing the Alter shredder, but has expanded its activities to encompass a movement *against* all metal shredders and *for* safe and clean recycling. Their activities include educating neighborhoods and organizations about metal shredders, supporting legislative efforts to prohibit or limit metal shredders along the Mississippi River, researching other metal shredders, and researching alternatives to metal shredding. NO SHAMS is committed to protecting the health and well being of West Side residents and preserving the integrity of the Mississippi River ecosystem.

This report addresses the current status of the automobile recycling industry, with a focus on the environmental and economic implications of developing technologies. It is designed to educate members of NO SHAMS! in the workings of the industry, in order to help them identify alternatives within the industry, assess the environmental impacts of different technologies, evaluate legislative options, and provide a factual base for public education efforts. While this report addresses both the positive and negative aspects of metal shredding, it was written with an eye on the long term goal of eliminating metal shredders and replacing them with a more efficient and environmentally benign alternative.

NO SHAMS! effort to eliminate metal shredders is timely. The automobile recycling industry is also paying attention to metal shredders these days. The industry's attention, however, is focused more on the by-product of automobile shredding than it is in the actual machinery. Automobile shredder residue (ASR or "fluff") is a subject of concern for the recycling industry because it threatens to make metal shredding unprofitable. For this reason, most discussion in the industry has focused on revitalizing the automobile recycling industry by reducing or eliminating fluff. This internal questioning provides an opportunity for outside voices such as NO SHAMS! to raise additional concerns about metal shredders. It is the right time for exploring alternatives.

This report has three main objectives:

1) to provide a working definition of recycling;
2) to describe the functioning of the automobile recycling industry; and
3) to explain some possible alternatives to the current state of affairs.

Recycling

Although recycling is a common buzzword, there is little discussion of what recycling is or how it functions. This report provides a working definition of recycling, with an emphasis on concepts such as "Closed Loop Recycling" and "Cradle to Reincarnation"[4] design, both of which may be useful in understanding the automobile recycling industry. "Closed Loop Recycling" is a system in which material is remanufactured into the same type of product it was culled from, with no net loss of material. "Cradle to Reincarnation" implies that human designers are responsible for all of the environmental impacts of a product from its creation until it is reprocessed into something new.

The Industry

The automobile is the country's most highly recycled consumer product. The automobile recycling industry is a huge enterprise, recycling almost 11 million cars each year (ARA "Automotive"). About 95% of retired cars enter the recycling system, and more about 75% of each car in the system is recycled (Winter, 85; PMI). The remainder is usually landfilled as fluff. A diverse and complicated infrastructure makes this possible. The major players in the recycling process are the last vehicle owner, the dismantling facility, the metal shredder, the steel mill, and the landfill. The industry is sustained by the inherent value of used auto parts and recycled metals.

Metal shredders are a crucial component of the current infrastructure because they can create huge quantities of scrap steel at low expense, making it possible for the industry to achieve high levels of profitability. During the 1960s, before the introduction of the shredder, the automobile recycling industry was rapidly becoming unprofitable. There is therefore a great reliance on shredders as an necessary and valuable technology. Overcoming this attachment to shredders is a necessary step in changing the recycling process.

Alternatives in Automobile Recycling

There are two major lines of thinking in automobile recycling. The first is to maintain the current infrastructure, but tack on a final process which utilizes ASR. The second is to design cars which are made of recycled commodities and can be easily dismantled, reused, and recycled part by part. The first option can be considered a short term solution to be used while the infrastructure and technology needed to implement the second are developed. However, even the *short term* solutions for recycling ASR require more research and development before they will be able to handle the huge amount of fluff produced every year.

Three major options have been proposed for dealing with fluff: alternative daily cover in landfills, fillers in composite materials, and feedstock for energy recovery via pyrolysis. Hypothetically, incineration is also an option, but it is considered a worst case scenario (below landfilling) as a means to deal with fluff because it doesn't burn efficiently. A variety of processes are being used to prevent the creation of fluff in the first place. Although the specific reprocessing technologies differ, all require some degree of dismantling before the steel hulk is crushed or shredded for scrap. The more comprehensive a dismantling process, the less fluff ultimately created. One American company, CARS of Maryland, has eliminated the shredder through state-of-the-art dismantling. This system is looked at in detail later in the report.

Another important factor in the recycling equation is the inherent recyclability of the automobile. This term refers to the potential of a car to be recycled using processes which are technically, economically, and environmentally feasible. Nearly all car manufacturers are experimenting with how to make cars more recyclable. However, this is a very slow process. It takes years for design changes to move from drawing boards to prototypes, and from prototypes to models for sale. After new designs are marketed, it still takes the lifetime of the car (currently 10-15 years) before they can be appreciated by the recycler.

Opportunities for change

The new movement for improved automobile recycling has its origins in European legislation. These laws were designed to deal avoid an abandoned car crisis brought on by a decline in the economic feasibility of fluff generation and disposal. They are also motivated by environmental consciousness. European legislation can provide a lesson in industry regulation.

While national legislation is one way in which change can be mandated, a variety of additional solutions also exist. This report was written with the view that federal regulation of the industry may be a long time forthcoming, and therefore recommends policy which can be implemented at the local level. One of the ways a municipality, county, or state can deal force changes in the automobile recycling industry is to enact legislation which makes status the quo recycling infrastructure (such as shredders) too expensive to locate in that area. Regional governments and citizen's organizations can also provide an environment which is favorable to progressive recycling systems, thereby attracting them to the area and fostering their development. Each of these options does have wide reaching effects, and careful planning about the ultimate goal of legislation is necessary. Municipalities also have the power to reduce the hazards of automobile recycling without attempting to change the industry: creating a community which is less car-dependent will reduce the number of cars on the road, and thereby reduce the number of cars going into the recycling system. Recycling is only one of a multitude of economic and social costs associated with the automobile. Alternative transportation methods are a key feature of any effort to create more environmentally sustainable community.

SECTION 2: CONCLUSIONS AND RECOMMENDATIONS

NO SHAMS! mission of eliminating automobile shredding and replacing it with a safer and cleaner technology is a complicated one. If metal shredders are put out of service before a new system can emerge, the country will be faced with an abandoned car crisis akin to the one which occurred in the 1970s. In order to avoid an environmental crisis larger than the ones posed by metal shredders , it is crucial that the transition from a shredder system to a more ecologically sound system is smooth. This requires the existence of technologies which can do the recycling work currently done by shredders. For the most part, such technologies exist: the trick is insuring they are put into practice.

Policy can be implemented on many different levels. Two of the most important arenas regarding automobile recycling are Congress and the car manufacturing industry. The federal government has the power to push recycling in a specific direction through legislation and, if necessary, subsidization. This is largely the strategy that has been used in Europe. The automobile manufacturing industry--be it because of legislative pressure, international competitiveness--also has huge capacity to enact change. Design decisions on the part of the carmaker can make automobile recycling a safer and more efficient process by eliminating the presence of hazardous substances in cars, making them more easily dismantled, making them out of recycled materials, and using materials which can be remanufactured several times. This report recommends stricter federal involvement in the automobile recycling industry, particularly in the form of environmental regulation and recyclability mandates to car makers along the lines of the present day Corporate Average Fuel Economy (CAFE) Standards.

Practically speaking, however, federal intervention in the industry does not seem likely in the near future. Therefore, most recommendations in this report will focus on action that can be taken at the local level. The following recommendations strive to accomplish the goals of NO SHAMS! while being informed by the understanding of the industry arrived at in this report.

1. Create national environmental recycling standards.

Congress can formulate a comprehensive policy akin to those designed in Europe. The European legislation has been very effective in enacting change in the industry. Some possibilities include making manufacturers responsible for final disposal (the German option), or taxing new car sales to fund an environmentally sound recycling infrastructure (the Dutch option).

2. Increase the expense of metal shredding

States, counties, and municipalities can enact legislation which makes it difficult to site harmful technology, such as metal shredders. This can be done by requiring that dangerous industries locate in specific industrial zones or enacting strict pollution laws which cannot be easily met by the industry. If this strategy is undertaken by a sufficient number of communities, then it will no longer be possible for the technology to operate profitably. Unfortunately, this strategies has two possible negative effects. First, the unwanted technologies will be forced to locate in more economically disadvantaged neighborhoods, cities, and states, exposing those populations to the health hazards of the operation. Even if the process is successfully kept out of every jurisdiction in the country, there is still the possibility that it can be profitably operated in a Third World country. This raises concerns about environmental and social justice. Second, if the technology is effectively prohibited before an effective substitute is made available, this environmental initiative can have the undesirable effect of creating a glut of abandoned and unrecycled automobiles.

3. Welcome environmentally friendly businesses

States, counties, and municipalities can create an environment which is welcoming to ecologically sustainable and community enriching companies. The Minnesota Office of Environmental Assistance lists a variety of loans, grants, and tax abatement programs which can be used to attract desirable growth. According to that agency, "Minnesota welcomes businesses that . . .add value to recyclables by processing to forms usable in new products or companies that make products with recycled materials (Luck, i)." Language such as this needs to be put into action. CARS of Maryland, a high-tech dismantling facility discussed later in this report was established with the help of financial initiatives from the state of Maryland and the City of Baltimore. Communities interested in hosting recycling technologies can also coordinate the needs of scrap producers and scrap reprocessors, helping businesses locate near their important markets. Not all recycling may be beneficial to citizens and nature, though. Recycling products which contain toxic substances (such as batteries or polyvinyl chloride foam) can release these toxics into the workplace and community. New policies should be written with the total environmental picture in mind.

4. Use government dollars to support green businesses

Local governments should support the production of environmentally designed products with their purchase dollars. Although a single small government can not have a huge impact on the balance sheets of any major corporation, it can make a difference to small local companies. The City of St. Paul is involved with local scrap yards and recycling facilities, especially through the vehicles collected at the impound lots. The city should make a concerted effort to support the company which is the best neighbor. A government contract could also be an incentive with which to encourage a state-of-the-art dismantling facility to locate within the city walls.

5. Educate others about automobile recycling

Citizens' organizations can communicate the importance of buying "green" products to other citizen and consumer groups. Most people (especially those who buy their cars new) have not given much thought to how their car will be disposed of down the line. Automobile recycling is largely invisible and needs to be brought to people's attention. Nothing will force car makers to improve faster than a shift in consumer dollars. This pro-active energy can serve as a complement to anti-shredder protest activity.

6. Decrease dependency on cars

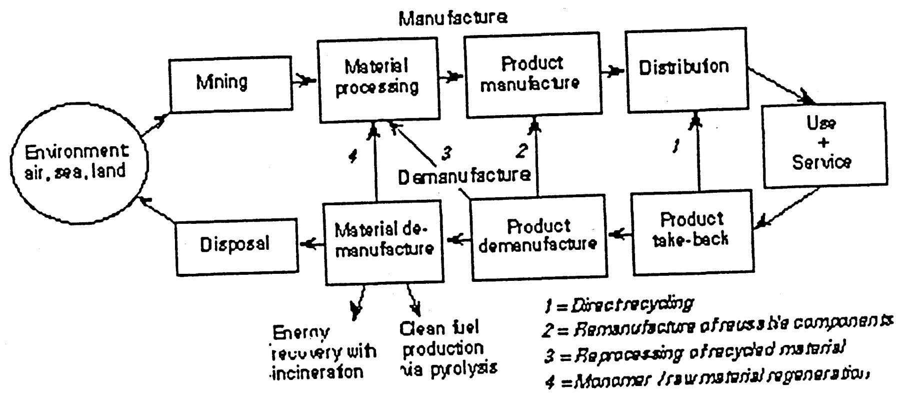
Cities must establish infrastructure which decreases automobile dependence. The problem of car recycling is just one among many environmental hazards brought on by over reliance on this one form of transportation. Mass transit, carpool benefits, and bicycle lanes are all a part of the solution. Not only will these items decrease the number of automobiles in the region, it will also lessen the use of the ones which do exist, thereby increasing their usable life.

SECTION 3: WHAT IS RECYCLING?

Recycling implies that material is processed out of one form and remade into a new product. The goal of recycling is to save resources, although this goal may motivated by a desire to save money or preserve the environment. When discussing recycling, it is important to keep in mind that recycling involves manufacturing. This means that it is not enough to find innovative ways to collect an item or take an item apart, but new technologies must also be developed to make use of the potential feedstock. From an economic standpoint, this is necessary to maintain an operative market. From an environmental standpoint, this is necessary to be truly "recycling." Otherwise, materials are being transformed into scrap, but resources are not being conserved and waste is not being reduced.

There are different levels of recycling. The highest is "Closed Loop Recycling," in which a product is remanufactured into the same kind of product, without the addition of any first-use material. Completely closed loops are extremely rare, though they are an important goal. If a material cannot be contained in a closed loop, it will often times be remanufactured into a lower grade substance, or combined with first-use material. In order to acquire maximum value, material should travel through as many different quality levels as possible. Steel is an item that can be remanufactured in a closed system. Automobiles, however, are not. This is because of the complexity of the product, as well as the inability of various car parts to be recycled in a closed loop. Plastics, for example, cannot be completely remade into products of the same quality as the original. They can be remade into either a lesser grade plastic, or mixed with a different material to form a new substance (Singh 41).

The diagram below offers an illustration of a possible recycling system. The upper right hand side of the diagram represents closed loop recycling ("Intro").



Reuse is often categorized as a type of recycling, although it is not technically recycling because reprocessing is not involved. But regardless of how it is formally classified, reuse certainly tops the list of how products should be dealt with in an environmentally responsible manner. In the words of D. Navin-Chandra, "Every time a part is reused, all the energy and emissions that were produced in its making and the processing of its materials are salvaged" (qtd in "Intro. . .). This understanding of how products should be dealt with is reflected in United Nations Environmental Programme's hierarchy for waste reduction (Murck et al 404). This hierarchy is also promoted by the US. Environmental Protection Agency (Selke 1):

1. Reduce
2. Reuse
3. Recycle
4. Incinerate
5. Landfill

The Reduce-Reuse-Recycle mantra are the well known poster children of this waste management hierarchy. What may be surprising to some, however, is the status of incineration above landfilling as an environmentally preferable choice. This is because incineration reduces waste volume and can be used to produce useful energy. Not technically recycling, this type of energy generation is known by the more general term, "resource recovery." With proper sortation and state-of-the art pollution control devices, incineration may not be the environmental and health hazard that it is often thought to be by communities. In fact, it is practiced successfully in many countries. However, the alleged safety of incineration and the real-life experiences of Americans living near incinerators do not always coincide. If the incoming waste is not carefully sorted or high-quality scrubbers are not maintained incineration can cause serious air pollution problems and leave behind a toxic ash which must be dealt with as hazardous waste (Rosenbaum 64). Incinerators are extremely unpopular in this country, which makes them extremely difficult to cite and build. Incineration is not a major issue with regard to automobile recycling, simply because it does not work very well (Selke). However, a different energy producing technology is on the table: pyrolysis[1]. This technology does not involve the direct combustion of waste like incineration does, but it is supported by the same principle waste management.

The concept of "cradle to reincarnation" recycling describes how each product should be designed with the potential to be remade into a new form of life. This phrase springs from the concept of "cradle to grave" or "lifecycle" product analysis, which looks at all of the natural resources involved with a product in its lifetime--from the emissions caused by its manufacture, to the toxic leachate it could cause in a landfill. "Reincarnation" expands this idea to mean that it is our duty to make sure natural resources aren't by being laid to rest in a garbage dump.

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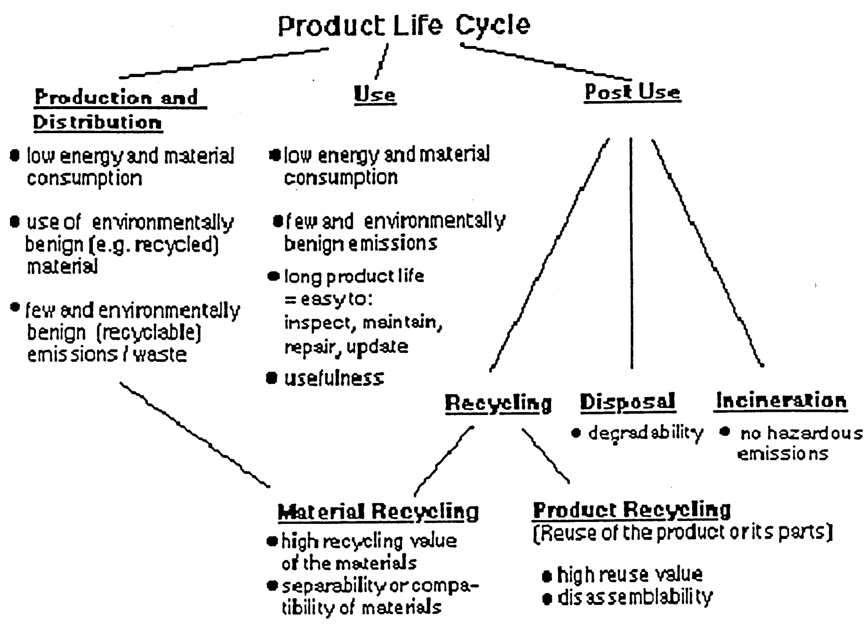
1 This process is explained in detail on page 28.

While recyclability is a key aspect of sustainability, it isn't the only thing which determines if a product is environmentally friendly. Every stage of a product's life has an effect on the environment. The diagram below illustrates some of the issues "cradle to reincarnation" analysis would use to determine a product's total environmental impact ("Intro").



The current concern about automobile recycling and automobile shredder residue in part results from conflicting environmental priorities. Increasing plastic content makes automobiles difficult to recycle, but they also make them much more fuel efficient. These conflicts does not imply that one environmental good must always be traded off for another. It simply means that a myriad of factors must be taken into account when a product is designed.

SECTION 4: INDUSTRY OVERVIEW

The automobile industry is the world's largest manufacturing industry. The recycling industry connected to it is also a huge enterprise, recycling over 11 million vehicles every year and supplying almost 40% of ferrous (iron based) scrap to the scrap processing industry (Princeton Materials Institute; ARA "Automotive"). While this complicated and well established infrastructure has been in place for economic reasons long before recycling was a popular environmental notion, recently it has been pressured to change its practices to become more ecologically sustainable. The industry proudly displays their environmental record, but groups such as NO SHAMS! also come into contact with the less laudable side of car recycling.

POSITIVE ASPECTS OF THE AUTOMOBILE RECYCLING INDUSTRY

- The North America industry employs about 80,000 people, and does almost $4 billion in gross annual sales (ADRA 2).

- Over 11,000 vehicles are recycled annually, making the automobile the nation's most frequently recycled consumer product (ARA "Automotive").

- The recycling infrastructure allows products to be made with less resources than would be required using first use (virgin) material. For example, substituting new parts for used replacements parts would require an additional 85 million barrels of oil each year (ARA "Automotive"). As a comparison to this number, humans have used about 600 billion barrels of oil to date, and geologists expect that another 1500-3000 billion barrels are possibly recoverable worldwide (Murck et al 288).

- 12 million tons of recycled steel are produced each year from scrapped cars, eliminating the need to create 12 million tons of steel from iron ore ("Recycling and the American Automobile").

NEGATIVE ASPECTS OF THE AUTOMOBILE RECYCLING INDUSTRY

- Each car recycled creates approximately 500 pounds of non-ferrous Automobile Shredder Residue (ASR), which generally winds up in a landfill. This "fluff" accounts for approximately 25% of each car, and is only expected to increase in the future as cars are constructed from a greater percentage of lightweight materials (Singh).

500 pounds per car x 11 million cars recycled annually
5.5 billion new pounds (2.75 million tons) of fluff in American landfills each year.

This is a major use of space: ASR accounts for almost 2% of all landfilled material (Field et al 3).

- Automobile Shredder Residue contains a variety of heavy metals and toxic substances. ASR is toxic enough to be classified as hazardous waste in some states. (Goodwin "Auto Shredder")

- The unrecycled portion of the vehicle which ends up as fluff represents a waste of potential resources. If 100% of each vehicle was recycled, significant resources could be saved.

* Motor Vehicle Salvage Facilities[2], the infrastructure through which cars are recycled, are extremely polluted sites. A 1995 study conducted by the Minnesota Pollution Control Agency found significant hazards of soil contamination or storm water runoff at most Minnesota facilities. At least 50 of Minnesota's 436 facilities (approximately 12 %) were found to be polluted enough to require intense cleanup efforts, such as is done through Superfund (MPCA 9).

* Poorly sited scrapyards and metal shredders can be burdens on their host community. People residing near metal shredders complain of noise, dust, vibrations, and explosions (Resource Strategies Corporation B-2, B-3).
  It does not appear that any specific studies have been done on the potential effects of metal shredders on wildlife, but the intense vibration may create a problem for animals and ecosystems.

General Operation of Today's Recycling Infrastructure

The environmental gains from automobile recycling listed above are possible because of an economically profitable infrastructure through which usable parts and commodities are recovered from end of life vehicles. The major players in this recycling scheme are the last vehicle owner, the dismantling facility, the metal shredder, the steel mill, and the landfill. The car (or remainder of it) travels through each of these steps in turn. In addition to these actors, there are also smaller processors involved. Shredded

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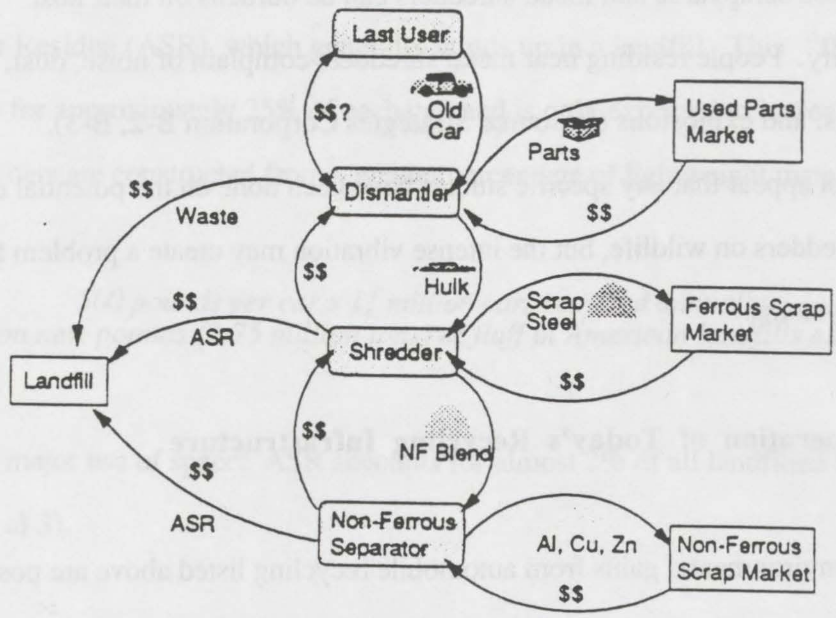
2 Motor Vehicle Salvage Facilites were defined in the MPCA study as "an establishement or place of business thatis maintained, operated, or used for storing, keeping, buying, dismantling, crushing, or selling wrecked, scrapped, ruined, or partially dismantled motor vehicles where the parts, motor vehicle hulks, or other scrap material stored is equal in bulk to ten or more vehicles." Although shredders are not specifically mentioned in this definition, shredders would also be included as a motor vehicle salvage facility because of the number of car hulks which are stored on the premises before shredding.

material may go to a separating facility to be sorted into ferrous metal, non-ferrous metals, and "fluff." Most frequently, however, this is done by the shredder company at the shredding site. Smaller salvage yards are also likely to sell their vehicles to a separate crushing facility, instead of directly to the shredder. There are also operations which focus solely on recycling one component, such as batteries or catalytic converters, while others support the recycling infrastructure, such as the used parts buyer or the towing company.

A schematic view of the industry is given below:



As you can see, money flows through these paths along with the material. Most frequently the money is exchanged for the material, but sometimes (as in the case of the landfill), money is needed to pass off the material. The flow of money from the last user to the dismantling scrap yard depends on the value of the car hulk (Field B-1).

Hypothetically, all of these processes could take place on a single site. However, that is rarely the case. By and large, the system is run by smaller processors who specialize in a single market niche. More than 90% of automotive recycling operations employee less than 20 people, and annually each shop processes and average of 1,500 vehicles (ARA 1996 survey). When thinking about automobile recycling, it is crucial to keep in mind that this is a long-standing and profitable industry. While the function recyclers perform may benefits environment, they are not exactly planting trees. Recycling facilities deal with some extremely hazardous products; like other types of industry they also contribute to local pollution.

SECTION 5: HISTORY OF THE AUTOMOBILE RECYCLING INDUSTRY

Automakers have been recycling since the days of Henry Ford (Sorge 67), but it was not until the early 1960s that recycling became a subject of national interest. Car disposal made it on the national agenda when abandoned cars began to pile up in junkyards and along the sides of highways. While policy makers knocked heads over a legislative solution to this problem, the abandoned car crisis resolved itself through technological innovation. The metal shredder was a crucial part of that solution. The resolution of the junked car crisis of the 1960s caused the recycling infrastructure to expand and become more sophisticated. From the 1970s until recent years, the car recycling industry has continued to buzz along without much national attention. However, car recycling has become a pressing issue on a global scale over the last ten years or so, and this time metal shredders are being directly implicated as a part of the problem. This is distressing to an industry which considers the metal shredder an economic savior.

Until the recycling crisis of the 1960s set in, automobiles were partially recycled by a simple infrastructure similar to today's salvage yard. During the 1940s and 1950s, most discarded or unwanted cars were acquired by salvage yards for the recovery of valuable parts and metals. Once the salable parts were removed, the hulks were set on fire to remove worthless combustible material. Acetylene cutting torches were then used to remove and separate the various metal components. Iron, heavy steel, light steel, and aluminum were sorted for scrap. The most valuable of this assortment were the light steel "No. 2" bundles[3], which were remanufactured in open-hearth steel furnaces (Dean et al 2). The late 1960s brought a change in steel making technology from the open hearth furnace to the basic oxygen furnace. Although this new process was an improvement from the

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3 The classification, "no. 2", refers to scrap obtained from end-of-life steel goods. "No. 1" scrap is metal which does not make it into durable goods, and is recycled within the industry. The important difference between the two is that "no. 2" contains a higher quantity of impurities which decrease the quality of the steel produced. The uses for "no. 2" scrap is therefore fairly limited (Field and Clark D-26).

point of view of the steelmaker, it decreased the value of steel scrap because it utilized only 28% scrap, compared to the 45% used in the open hearth process (Field and Clark D-8). The newly depressed market for steel, coupled with new auto burning bans enacted by localities concerned about air quality, made operation very difficult for the salvage yards. Businesses which had once paid for car hulks began charging owners to take end-of-life vehicles (Field and Clark D-9). Instead of being recycled through the appropriate channels, thousands of abandoned cars began to rust on public roads and in makeshift junkyards.

During the 1960s, the ugliness of junked cars (and concurrent property value declines) made its way onto the national agenda. Several policy recommendations were set forth to deal with this situation--some quite similar to the legislation currently being enacted in Europe to finance comprehensive dismantling. However, before any national legislative action could be taken, two technical fixes resolved the problem. The first of these was the advent of the electric arc furnace. This is the technology of "mini-mills," such as the one operated by North Star Steel in St. Paul, MN (Reed). Electric arc furnaces spread quickly through the industry because of their technical superiority over basic oxygen furnaces and their relatively low start-up costs. Scrap yards benefited immensely from this change because electric arc furnaces utilize nearly 100% steel scrap--as electric arc furnaces increased in number, the price of steel skyrocketed. A second invention then made it possible for salvagers to cheaply supply furnaces with that scrap: the metal shredder. Metal shredders (and their attached sorting mechanisms) ingest whole automobiles, hammer the vehicle into fist sized hunks, and separate the pieces as ferrous metal, non-ferrous metal, and "fluff" or automobile shredder residue (Field and Clark D-13). The resulting ferrous product is easily used by the furnace industry, because most tramp elements (non-ferrous metals) are sorted out.

Practically overnight, the technical combination of the electric arc furnace and the metal shredder changed the end-of-life automobile from an environmental, safety, and aesthetic hazard to a valuable commodity. Illegal junkyards were instantly turned into million dollar gold mines (Shreck). Metal shredders are the most lucrative technology of the automobile salvage industry. Not only did they revive the automobile salvage industry from its near death in the 1960s, but they jump started its expansion as well. Between 1974 and 1977, more cars were shredded than were retired, as shredders culled hulks from "the national inventory"--our collection of abandoned vehicles (Julius Hardwood qtd in Field and Clark D-13). A steadily growing car industry sustained the increased recycling potential.

The Importance of History

This historical look at the automobile recycling industry is important for two reasons. First, it gives a background of the industry and helps explain the attachment of industry members to metal shredders. Metal shredders are not seen as one recycling option among many. Second, and more importantly for NO SHAMS!, this history has implications for how the industry chooses to deal with the current problem of automobile shredder residue.

As discussed above, the junk car crisis of the 1960s was resolved because of the emergence of technically possible and economically profitable processes. Legislative fixes were not necessary. It has been argued that this experience has led to a "sit and wait" attitude among both the automobile manufacturing industry and the automobile recycling industry (Field and Clark D-24). This perspective calls for the evaluation of potential short and long term solutions, but no immediate action to eliminate metal shredders or ASR. Metal shredders may eventually make themselves unprofitable, the argument goes, and at that point the industry will change to make itself profitable again by accommodating new technologies. These new technologies will either replace shredders or reprocess ASR. The actual shredder is a problem only for those who live near them. It is important to understand that metal shredders are considered to be problems-in-themselves only to the people who live near them or work in them. The car recycling industry is only concerned with shredders to the extent that they produce fluff, which is seen as the "real" problem.

As Alter Trading Corporation's effort to build one has shown, metal shredders are extremely profitable operations. This is apparent in the number of scrap companies that have been building shredders in recent years. The nation already has over two hundred metal shredders, and these new additions are beginning to swamp the market. While scrap companies continue to build shredders, the overall rate of scrapping is declining. This is in part because cars on the road today are designed to last longer than previous models. Whereas 5.5% of cars were scrapped each year in 1970, 4% were scrapped in 1993 (Kuster 44). This market glut will lead to increased competition for car hulks, which will in turn reduce the profitability of the industry and is likely to drive some shredders out of business. Because the life span of a shredder is a fairly short 10-20 years (Schreck), scrap dealers may feel that they will be able to make back their investment before the market is unprofitably saturated.

An overabundance of metal shredders means two things for environmentally sound recycling. First, it means that more shredders exist than are technically needed, creating unnecessary air, soil, water, and noise pollution. Second, on a more optimistic note, a glut of metal shredders may reduce the profitability of shredding which could cause the industry to experiment with new--and more socially acceptable--alternatives.

The "sit and wait" philosophy may make sense economically, but from an environmental perspective it is flawed. The ability to profitably remanufacture shredder waste may be a step in the right direction, but it is not an environmental cure-all. There is no guarantee that new technologies will be any less disruptive to communities and ecosystems than metal shredders are. An appropriate environmental perspective would serve to "close the loop" of the car making and recycling system, as well as question why we need so many cars in the first place.

SECTION 6: THE PROBLEM OF FLUFF

Metal shredders have been the primary means of recycling automobiles for more than twenty years. Since the late 1980s, however, there has been increasing concern about the shredding process. Some of this comes from community groups such as NO SHAMS!, who oppose the environmental and community hazards associated with metal shredders. But most of the attention has not focused on the shredder itself, but on the huge quantities of automobile shredder residue produced--about 3 million tons per year. This fluff is made up of the non-metal components of a car: glass, ceramics, cloth, rubber, plastic, and foam (Boeger and Braton 133). Nearly all of this fluff is landfilled. Landfill tipping fees are fairly low in the United States, so landfilling is not an excessive burden for most American companies. However, fluff is already an enormous problem in Europe and Japan, where tipping fees may be ten times what they are in the US (Eller 19). Fluff also contains a variety of toxic substances, including high levels of heavy metals such as cadmium, lead, and mercury (Rust v). These contaminants make it possible to classify shredder fluff as hazardous waste.

In addition to the solid waste issues, discarded fluff can be considered a waste of resources. Instead of being "reincarnated" into a useful product through remanufacture, the next life of the non-recycled portion is as toxic leachate seeping through a landfill.

Reasons why shredders and ASR are problematic:

- **Environmental concerns**: Vehicle hulks, shredded metal, and fluff kept on the grounds of a shredder site can be a significant source of soil, ground water, and stormwater runoff pollution (Swamikannu 44). In addition, the outdoor operation of metal shredders creates large quantities of fugitive dust and significant noise pollution.

- **Neighborhood opposition:** This opposition involves a concern for ecosystem quality, human health, and community well being, all of which reflect the above issues. Protection of property values is also a reason for opposition.

- **Cost of environmental compliance:** Preventing pollution and complying with government regulations makes the operation of metal shredders (as well as all salvage facilities) more expensive.

- **Possibility of increased disposal costs:** Some states have considered identifying ASR as a hazardous waste, which would immediately increase disposal costs (Goodwin "Pyrolysis"). This may also become an issue as tipping fees rise because of a lack of landfill space.

- **Increase in per car fluff volume:** As automobiles continue to be made of more plastics and composite materials, the amount of valuable ferrous metal that can be recovered from the auto hulk is reduced. This number is only expected to increase as car makers come under increasing pressure to increase fuel efficiency through the use of lightweight materials (Selke 2).

- **Lack of long term gain for host municipality:** Metal shredders have a 15-20 year life span, after which they are worn out and obsolete. They also create only a small number of jobs. The combination of these two factors, coupled with the potential loss of surrounding property values and ecosystem health, mean that a shredder probably does not create a net economic gain for the host city.

There are two major lines of thinking in automobile recycling. The first is to maintain the current infrastructure, but tack on a final process which utilizes Automobile

Shredder Residue. The second is to design cars which are made of recycled commodities and can be easily dismantled, reused, and recycled part by part. The first option can be considered a short term solution to be used while the infrastructure and technology needed to implement the second option are developed. However, even the *short term* solutions for recycling ASR require more research and development before they will be able to handle the huge amount of fluff produced every year.

Short term solutions for Automobile Shredder Residue:

Alternative Daily Cover

One option, which does not reduce the quantity of fluff landfilled but may reduce the cost of landfilling it, is using ASR as daily cover material. Modern landfills routinely cover their daily garbage fill with about 15 centimeters of dirt each night in order to minimize odors, control rats and seagulls, and provide a traction surface for equipment. Recently, landfill owners have begun experimenting with materials separated from their incoming waste stream as an alternative to dirt daily cover. This can extend the life of the landfill, save useful soil, and (in cases where dirt is not readily available) cut costs. ASR is being used as alternative daily cover in at least seven states (Rust 12), including a Davenport, Iowa landfill operated by Alter Trading Corporation (McGuire).
Some characteristics of ASR which are appealing to landfill operators:

- ASR compresses from the mandatory 15 cm overnight layer to less than 5 cm, which extends the total capacity of the landfill.

- ASR is not as prone to the same degree of rainfall erosion as is dirt cover.

- ASR provides a more stable operating surface for heavy equipment than does dirt cover.

- ASR is less prone to dusting than is dirt cover.

- ASR can be delivered to the landfill at no additional cost to the operator (Day 30).

ASR also has a surprising quality which affects its success as daily cover. Although ASR often contains a high quantity of heavy metals, it also has a considerable absorptive capacity. A preliminary study of ASR properties revealed that although the sampled fluff contained a large amount of lead, it had a low 24 hour lead leaching level: its absorptive capacity was actually greater than its leaching potential. This suggests that a daily cover of ASR is capable of acting as a lead filter for the leachant of the garbage above it, reducing the overall potential of ground water contamination. This study of absorption capacity demonstrates how little is known about the properties of ASR. It needs to be backed up with future research, because it did not address heavy metals other than lead, or analyze leaching potential over a time longer than 24 hours.

From a solid waste management perspective, this use of fluff is great news. While it means that ultimately fluff is still ending up in the landfill, it extends the life of the landfill by keeping 15 centimeters of dirt out of the landfill each day. In addition, if the research described above turns out to be valid, fluff as daily cover also becomes a hazard mitigation technique. Groups such as NO SHAMS! cannot view it so positively. At the moment, the expense of landfilling fluff is the most significant factor in industry's efforts to find an alternative to automobile shredding. But if the use of fluff as a daily cover allowed a shredder to deliver its fluff to the landfill free or at reduced cost, the economic push to stop shredding would be eliminated. Although this is not an adequate long term solution, widespread use of ASR as daily cover would be enough to get the issue of recyclability off of the table for a while. This puts shredder opponents in a sticky position because it means that supporting an environmentally beneficial use of material (ASR as daily cover instead of fill) may lead to a long term negative effect on the environment (the perpetuation of metal shredders). Without scientific evidence discrediting this process, shredder opponents will not be able to--and may not want to--prevent fluff from being used as alternative daily cover. However, they must be vocal in keeping sustainable long term alternatives to automobile shredders on the agenda.

Composite Materials

ASR also has potential applications as a feedstock for new plastic goods such as fence posts or park benches. This is sometimes done by combining the plastic component of fluff with some other plastics in the recycling stream, such as household containers made of HDPE-type plastic (yogurt containers, for example) . The variety of plastic types, as well as the bits of glass rubber, rust, and dirt which are in ASR make it impossible to create a high grade plastic product. However the resulting substance from a plastic ASR mix can be used as a low grade construction material, comparable to widely used building materials. The chart below offers a comparison of ASR-plastic composite and other materials (Day 31).

FLEXURAL STRENGTH OF CONSTRUCTION MATERIALS	
MATERIAL	FLEX STRENGTH
Plywood	79
Soft wood	56
100% HDPE	42
50/50 ASR/HDPE	27
Particle Board	10
Masonite	7

The use of ASR as a plastic feedstock has been slow to develop because the resulting product has many inexpensive substitutes made from first-use material (wooden park benches, for example). Maintaining the processing equipment is difficult and expensive, and the product demand necessary to sustain the market does not exist (Rust, 10). Perhaps upgraded technology could make this option more popular, but at the moment it does appear to have a bright future. Environmentally focused *life cycle analysis*[4] would be useful in evaluating this technology to insure that it can be used to create durable and necessary products. The world only needs so many shingles and lampposts, especially ones which would be quick to degrade.

Pyrolysis

The most hopeful solution to the problem of Automobile Shredder Residue is the use of pyrolysis as a means of reducing residue mass and generating useful energy. Although it is still in the infancy stages and has not yet been put to profitable use as a means to deal with fluff, high hopes are being pinned on pyrolysis as a means of dealing with ASR.

Pyrolysis is a technology of controlled thermal decomposition in which the ASR is heated in an oxygen-free chamber. Roughly fifty percent of fluff is organic (carbon-based) material: this portion is condensed into “pyro-gas" and "pyro-oil" during pyrolysis. The remaining inorganic component creates a residual solid (Goodwin). The process is illustrated in the diagram below (Day 31):

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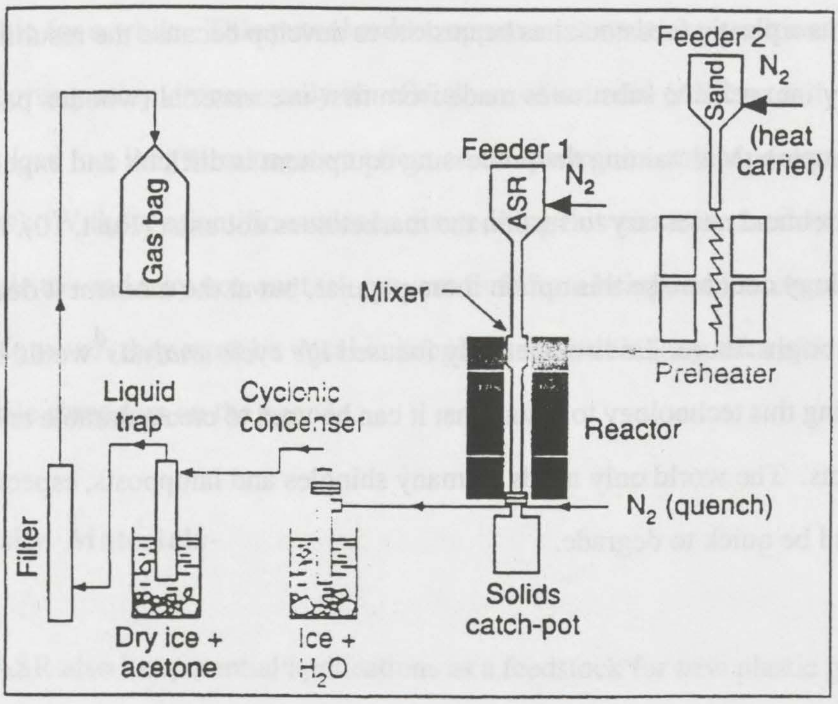
4 This concept is explained on page 13.



The process begins when sand or nitrogen is heated (feeder 2) to be mixed with ASR (feeder 1). The hot ASR/sand mixture travel through a cylindrical reactor, in which the carbon separate from the organic materials in the fluff. The mixture is cooled (by Nitrogen, in this example) upon leaving the reactor, and the solid, inorganic material collects in the catch-pot. The liquid fraction is trapped in one of two cooling chambers, and the remaining gas travels through a filter to be stored in a gas bag.

The Pyro-oil and pyrogas created in pyrolysis are similar in composition and performance to natural gas and heavy crude oil, respectively, and can therefore be burned for heat energy (Singh). The pyrolysis process--which operates at approximately 1400 degrees Fahrenheit--uses up about 25% of the pyrogas created (Goodwin #2). Hydrocarbons usable for making other plastic products may be recoverable from the pyrogas and pyro-oil but require additional treatment before they are acceptable to the petrochemical industry (Day 31). The residual solids may have applications as fillers in sheet molding composite (which makes up a substantial chuck of the ASR) and certain types of plastic, as well as in asphalt. However, the technology necessary for making these composites is still in a preliminary stage(Goodwin "Pyrolysis"; Singh et al). One potential limit on the success of residual solid feedstocks is the ample selection of alternative materials.

The final composition and fuel yield of the pyrolysis products are determined by the organic content of the ASR, and the duration and the temperature of the reaction. Generally, 50%-70% of the final product is residual solid, 7-23% is dry pyrogas, and less than 1% is oil. The remainder is water. Additional time and higher temperatures can lead to further decomposition, increasing the ratio of pyrogas to residual solids (Day 31). These percentages demonstrate that pyrolysis may be a step towards eliminating ASR, but it is certainly not an ideal solution. This is especially true while technologies for utilizing the solid residue and purifying the hydrocarbon portion remain undeveloped.

Pyrolysis technology has yet to be implemented in a large scale. Building a pyrolysis operation costs between one and two million dollars (Goodwin "Pyrolysis), and it is not clear that such an investment would be cost effective or environmentally beneficial. At the moment, pyrolysis operations can only process about 1 ton per hour. Capabilities of 15 to 20 tons per hour may be needed before economic feasibility is achieved (Sorge 67). The ultimate value of pyrolysers may be that they defer material from expensive landfills, and not as profit generating operations in themselves. The economic picture ultimately depends upon the efficiency of the pyrolysis process: would pyrolysers pay shredders for ASR feedstock, or would shredders pay pyrolysers to dispose of ASR waste?

At the moment--as Alter Trading Company's efforts have demonstrated--automobile shredders are highly lucrative. Pyrolysers, even if profitable, would probably have a much lower profit margin than shredders, making it unlikely that shredding companies would be interested in venturing into this emerging technology (Field A-13). As long as landfill fees remain low and the non-ferrous portion of cars does not increase drastically, there is little incentive for the American auto recycling industry to develop pyrolysis technology. The push for pyrolysis is therefore not coming from the scrap industry, but automakers who may ultimately be responsible for the waste through mandatory take-back or recyclability-content laws. Pyrolysis may be more important in Europe, where landfill costs are much steeper, and (in the case of Germany) automakers are already responsible for disposing of end-of-life vehicles. American automakers which produce and sell in Europe are also subject to the recycling laws, giving them a reason to explore pyrolysis.

Beyond the economic picture, more research needs to be done with regard to the environmental implications of pyrolysis. While the amount of landfill space required is reduced, there are other environmental effects which also need to be considered. Among those rooting for pyrolysis are voices claiming that conservation necessitates all petroleum being made into durable goods before it is converted back into combustible fuel. That way, the oil serves two useful purposes in its lifetime. At the moment, 95% of burned within several weeks of being pumped and 5% is turned into material goods (Sorge 67). However, pyrolysis has already been criticized by many environmentalists for causing more pollution than would fossil fuel (Sorge 67). The *process* of pyrolysis, unlike incineration, does not create energy. The pyrogas and pyro-oil must be burned like fossil fuels, releasing carbon dioxide and other emissions into the atmosphere. The life span of the pyrolysis plant must also be analyzed to insure that the amount of waste created by the building and maintenance of the plant is not greater than the waste it is intended to eliminate. It is also unclear what happens to certain specific hazardous components in fluff, such as the chlorine from polyvinyl chloride--the vinyl in our cars (Day 31; Holt 42). Polyvinyl chloride is a type of organochlorine, which are some of the most toxic compounds produced by the chemical industry. Organochlorines have a massive effect on the endocrine and immune systems, which is manifested in cancer, infertility, immune suppression, birth defects, and stillbirths (Hawken 40). Keeping track of organochlorines as they move through the recycling infrastructure is essential, and pyrolysis cannot be considered an appropriate technology until it is clear that there is no danger from polyvinyl chloride.

Pyrolysis does appear to have short term value because of its potential to reduce waste volume and produce useful hydrocarbons and energy. However, to identify it as "good recycling" would be a misnomer. Recycling, as discussed earlier, depends on the production of new materials from used ones. "Closed-Loop Recycling," which is considered to be the highest form of recycling requires that materials are "reincarnated" as the same type of product they were culled from. Closed loop recycling is rare in industry, but it is an important goal. If Closed loop recycling is not possible, the most value can be obtained from material if it undergoes only a small reduction in quality each time it is reprocessed. Pyrolysis instantly consumes material (namely plastic and the other components of fluff) which could otherwise be used in manufacturing new products. It can therefore be understood as a net loss. As a short term solution, it may be a better way to deal with ASR than immediate landfilling. However, the inadequacy of this solution demonstrates the need for automobiles made of truly recyclable materials.

More information on the technical capability, environmental implications, and economic viability of pyrolysis has been compiled by the Canadian National Research Council. This report may be a good source for any community, government or business interested in or concerned about pyrolysis. It is not owned by any American libraries, but can be purchased directly from the Council.

The Argonne Method

Researchers at Argonne National Laboratory in Chicago have been developing an ASR separating technique which would enable more precise ASR recycling and reduce waste by as much as 75% (Rust vii). The "Argonne Method," as it was dubbed in the MPCA Automobile Shredder Residue Report, separates the usable components of ASR in to three categories: polyurethane foam (15-20 of ASR weight), particulate iron "fines" (30-40%), and plastics (about 50%). The first two categories have immediate remanufacturing potential. The foam can be used again in such things as carpet padding or sound suppression in automobiles. The iron fines, which are less than one-quarter of an inch long, can be purified and used as a cement feedstock. Because of the presence of zinc and alkali metals the fines cannot be reprocessed as scrap. Further research still is needed for the plastics-rich stream (Goodwin #1). The Argonne Method is a three step process: physical separation, solvent treatment, and solvent recovery. Physical separation occurs via a series of vibrating screens. The solvent treatment creates a removes waste material from the polyurethane foam because it has greater remanufacture potential as a clean product. Solvent recovery is a distillation process in which the plastic waste is separated from the solvents so they can be reused (Rust 34).

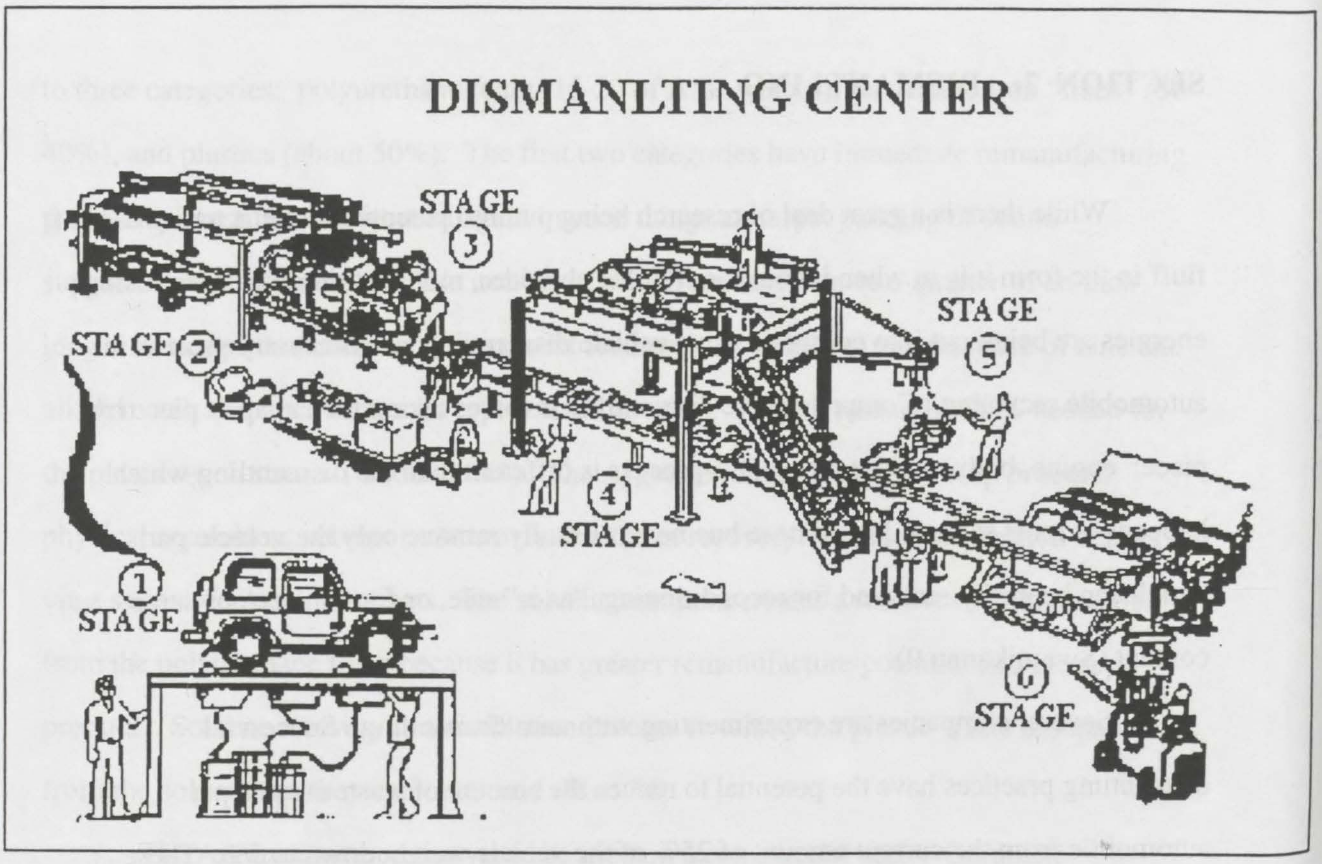
The Argonne method has yet to be tried on a commercial scale. Complete environmental analysis is needed before this process is used as an environmentally beneficial alternative to landfilling.

SECTION 7: DISMANTLING

While there is a great deal of research being put into potential manufacturing uses of fluff in the form it is in when it comes out of the shredder, more visionary and promising energies are being put into comprehensive vehicle dismantling as a necessary process in automobile recycling. Comprehensive dismantling involves taking the car apart piece by piece: engine, body, and interior. This process is different than the dismantling which happens at most salvage lots. Those businesses usually remove only the vehicle parts which can be easily removed for reconditioning, "as is" sale, or for non-ferrous scrap content (Swamikannu 9).

Several companies are experimenting with auto dismantling. Successful dismantling practices have the potential to reduce the amount of waste created per automobile from the current amount of 25% of the vehicle weight down to 5%. These operations first emerged in Europe because of high landfill costs and political pressure for the recycling industry to be "greener." Many European automakers have started experimental auto dismantling shops, including Peugeot-Citroen, Renault, BMW, Volkswagen, Audi, and Volvo. Many of these operations are joint ventures, either between car manufacturers (such as the partnership between French car makers Peugeot-Citroen and Renault [Goodwin "3 Automakers"]), or between the car maker and an established scrap business (as Volkswagen has done by teaming up with Preussage Recycling GmbH in Germany [Penson 7]). American car manufacturers are also experimenting with dismantling in Europe.

The diagram below demonstrates how one recycling option, the *dis*assembly line, could operate. This schematic is based on the system of a Dutch company, de Mosseleaar BV ("Intro. . .").



Automobile Dismantling Line at De Mosselaar BV in The Netherlands

stage 1: fluids are drained and recovered

stage 2: major interior body parts are removed

stage 3: major exterior body parts are removed

stage 4: the car is tilted for the removal of underside components such as axles and exhaust system.

stage 5: the engine and transmission are pulled out of the car

stage 6: the remaining "hulk" is compacted, shipped to a shredder ("Intro. . .")

As you can see, a process such as this greatly reduces the amount of trash going into the shredder, and therefore the amount of fluff coming out. While this process does not completely eliminate the need for a shredder, it greatly reduces hazards associated with shredders such as fugitive dust, water and soil contamination, and landfilling. Innovative recycling operations such as the de Mosselear system have been developed in Europe primarily in response to high costs of fluff disposal. Landfill tipping fees in Western Europe range from $175-$715 per ton and are increasing (Eller 19), so the shredding-as-recycling process--which produces more than 500 pounds of fluff per car--threatens to become an economic liability (Holt 42). While disposal costs in the US are much lower--the tipping fees in Ramsey County range from $38-$66 per ton--fluff reduction and shredder elimination are becoming increasingly important issues(Reed)[5].

One Baltimore based company, Comprehensive Automotive Reclamation Services (CARS) of Maryland, has introduced the total dismantling concept to the United States. CARS is using Dutch technology to operate a labor intensive, economically profitable, and environmentally sound disassembly and recycling system. The CARS system is potentially able to reduce the amount of landfilled material to less than five percent of total car weight, as well as eliminate the need for metal shredders. CARS provides a model of what auto recycling may look like in the future[6].

CARS is a visionary project. The first dismantling operation in the United States, CARS was created through a partnership of William Hyman, an environmentally conscious entrepreneur, and Jay Cullen, an insider in the auto industry who provided necessary start-up funds and crucial contacts with General Motors. The plant is located in the low income neighborhood of Orangeville, on Baltimore's East Side. This area has been designated an enterprise zone, which allows CARS access to six acres of city land tax-free, in exchange for employing a certain number of local people (Worden). CARS is a for-profit business: like other auto recyclers, it exists to make money. But it was also founded to bring state-of-the-art green technology to this country, and demonstrate that cars can be profitably

5 There are several reasons for this. See list on page 10.

6 All information about CARS of Maryland which is not otherwise cited was obtained during two telephone interviews with Nancy Sewell on March 13, 1997 and April 21, 1997.

recycled without harming ecosystems or human communities. This attitude of environmental stewardship seems to be pervasive throughout the entire company.

At the moment, CARS is the only operative disassembly plant in the United States. The company has been in operation since 1996, and expects to be operating in the black by June of 1997. Currently, 80 people are employed, although 200 employees working between three shifts is ultimately expected. The full production capacity of CARS is 30-40 thousand cars per year. According to the Automotive Recyclers Association, 11 million cars are scrapped annually in the US, so while this number is significant it is not exhaustive (ARA "Automotive"). The company envisions that 100-150 such plants will be operating in this country within their first ten years of existence--a quantity which could account for approximately 50% of this country's end-of-life vehicles. Because CARS owns the US patent rights to the technology, it is evident that they plan on dominating the market.

CARS operates similarly to the De Mosselaar disassembly line described above using equipment purchased from another Dutch company, Car Recycling Systems B.V. Several state-of-the-art dismantling systems hail from the Netherlands because the National Environmental Policy Plan of that country finances environmentally sound automobile recycling (Johnson). Each step of the dismantling process has been designed to insure maximum environmental protection and maximum recyclability.

A quick overview of how the plant operates:

End-of-life vehicles are brought to the facility, mainly by local towing companies and salvage auctions. Like other salvage lots, many of the cars which come in have been "totaled" in accidents, and are ready to be scrapped. For example, Nationwide Insurance brings all of their destroyed vehicles from the region to CARS. Immediately, the cars are drained of all fluids. (CARS maintains this process 24 hours a day). The fluids are kept separated, and are sent to various reprocessors who have the specialized equipment necessary to deal with such substances. Gasoline and oil are burned on site to heat the 200,000 square foot facility. The immediate fluid draining works to prevent the type of ground contamination which is present at most scrapyards (Swamikannu 66). As a safeguard, the premises are also monitored for ground contamination.

The actual dismantling process takes place indoors in a refurbished warehouse. All parts are removed and sold in large quantities to be rebuilt or sold "as-is". The sale of used parts is the greatest profit maker for CARS and what allows them to afford more elaborate and time consuming dismantling. All metallic materials are stripped from the car, to be sold for remanufacturing. This is one area in which the advantage of a large dismantling plant over a small salvage facility is evident. Many non-ferrous metals in automobiles occur in small quantities and are difficult to remove from the vehicle. They also do not attract the high resale price which would make extraction profitable. Instead the non-ferrous elements are sent with the car hulks to the shredder, where they are broken into small pieces and mechanically separated again. This process causes small bits of the metals to get mixed up with other types as "tramp" elements, which reduces the metal's potential to be remanufactured into a high quality product. In addition, some of the shredded metal becomes fugitive dust which settles out of the air to become ground contamination. CARS however, has the scale and the machinery to make dismantling possible. GM (who supplied original funding for CARS) has an agreement to buy all commodity items, which benefits CARS by creating an automatic market for their scrap and GM by giving them a discount on the materials. This commodity sale includes steel, catalytic converters (which contain platinum), aluminum, copper, and batteries.

Tires are sold for recycling through a three-tiered system: the best ones are destined to be resold as used tires, medium grade ones are retreaded for sale, and the unusable ones are processed for heat recovery through pyrolysis[7]. Plastic remanufacturing is similarly outsourced. Because the complex mix of plastics used in every modern automobile makes complete plastic separation extremely difficult, the plastic is removed from the car frame en

[7] The pyrolysis of tires is similar to the ASR pyrolysis technique discussed earlier. Tires, unlike ASR, have been successfully pyrolysized on a commercial scale.

masse. CARS is working with an outside entrepreneurial venture to develop a mixed plastic product derived from the various plastics removed from cars. As the recyclability of automobiles increases, removing and reusing or recycling plastic components individually may be possible. Other materials in the car, such as glass and foam, are either sold for remanufacture or landfilled appropriately.

As new remanufacturing technologies emerge and vehicles are designed to be more recyclable, the percentage of landfilled material will decrease. The ultimate goal of CARS is to make sure that less than 5% of the car mass ends up in a landfill; they are continually working with scrapped based manufacturers to develop new ways of reusing car parts. After the entire dismantling process is completed, the car body--stripped of all non-ferrous components--is baled and shipped to a steel mill, where it can be remanufactured without prior shredding.

CARS is unique in the international scene (though this may change as processes become more sophisticated) in that the car hulks it produces can be used--unshredded--by an electric arc furnace. It remains economically successful for the same reason that most scrapyards can turn a profit--because of the inherent value of the parts and materials in automobiles. Although CARS does have expenses beyond the typical salvage facility because of the extensive dismantling they do, they also are able generate a larger income. The large volume of vehicles traveling through the facility, coupled with the comprehensive dismantling done there, creates a reliable supply of used parts that are continuously sold to other businesses. Typical scrapyards tend to send a large number of these vehicle parts to the shredder with the car hulk, thereby wasting a valuable source of income. Also, by selling directly to the steel mill, CARS is paid for the full worth of the steel scrap. The implicit cost of shredder maintenance and ASR disposal present in the scrap price paid to the salvage yard from the shredder are absent. In the words of John Resslar, a product engineer at Saturn, "[recycling by shredding] is the industry standard. It's considered the state of the art. But the process results in major contamination of the components. Any components that can't be removed are destroyed. Plus, the shredding process is extremely energy inefficient (Varacchi 34)."

Automobile dismantling was pioneered in the Netherlands as a means of reducing waste, and was thought to be unprofitable. In fact, the process was financed through a $100 green fee that was tacked onto the cost of every new vehicle to pay for appropriate dismantling, recycling, and disposal (Green Plans). CARS of Maryland has demonstrated that vehicle recycling can be profitable in the United States, and is seeking to change the way end-of-life vehicles are disposed of in this country.

Insurance companies are particularly interested in supporting vehicle dismantling efforts, because they save money every time a car is fixed with a used car part instead of a new part, and they benefit from having an ample, consistent supply available from a dismantling company. American Reinsurance, which provides insurance for insurance companies, is taking an extremely active role in CARS: they recently made a $2.5 million investment in the company, and are pushing CARS to open a second facility as soon as possible. Although CARS and American Reinsurance are thinking of sites near the original Maryland facility, they plan to open dismantling plants across the country in the near future.

In addition to the potential improvements for environmental and public health, comprehensive dismantling and recycling makes sense from an *economic* point of view because the separated parts and commodities supplied by the dismantler are usually more easily remanufactured than ASR. This is due to the fact that the constituent materials of parts occur in identifiable and consistent ratios. Specific reprocessing techniques can therefore be used to make the most efficient use of each unique component.

The dismantling plant--like the shredder--is only an intermediate step in the recycling process. The system cannot function without appropriate and cost-effective reprocessing technologies or markets for the reprocessed goods. State-of-the-art dismantling and remanufacturing technologies cannot compensate for vehicles which contain toxic substances or parts designed to be thrown away. The success of automobile recycling ultimately depends on decisions made by the car maker. The most important changes need to take place on the drawing board. Through their choices in materials and design, car manufacturers can increase the feasibility of dismantling and stimulate markets for reprocessed materials. Cars can be designed to be more sustainable: in 1941, Henry Ford build a ethanol-powered prototype car which had a soybean plastic body and goldenrod derived tires (Hawken 67)." The design potential exists. It is a matter of getting ideas from the drawing board to the show room in an ecologically sustainable, economically viable, consumer acceptable automobile.

SECTION 8: DESIGN INITIATIVES

Inspired by European legislation, auto makers have begun to pay attention to the recyclability of the cars they produce. Nearly every major manufacturer has a recycling lab where dismantling designs and recycled-content products are tested. The Big 3 American companies--Chrystler, Ford, and General Motors--collaborate on this issue at the Vehicle Recycling Partnership (VRP) outside of Detroit. Parts which currently end up as fluff are a research priority. Among other goals, the automakers have pledged commitment to eliminating toxic materials from their cars (Cogan). The VRP operates with a budget of about 1 million dollars, provided by the Big 3 via cash, personnel, and useful products and commodities (Walkowicz). This is an important start, but its real value will be revealed when the research done finds its way into the cars we drive. Significantly more resources could be spent on the problem then the corporations have committed. As a comparison to VRP's budget of 1 million dollars, keep in mind that auto recycling is a 4 billion dollar industry.

Individual companies can have also taken initiative to make a more recyclable car. Saturn, a subsidiary of GM, is the best American example of this. As a part of their comprehensive "Design for the Environment" policy, Saturn is attempting to build a car which is potentially 99% recyclable . Saturn is an unusual case among American auto makers, because the company was created to serve as General Motor's laboratory for efficient car design (Varacchi 34).

The recycling industry has also stepped in with an attempt to look and be more environmentally responsible. The Automotive Recyclers Association has established a program called "CAR" (Certified Automotive Recycler), which identifies scrap facilities as having pleasant and clean business practices, environmentally sound management, and premises safe for workers and customers ("CAR" 19). The advantages expected from this system include flexibility in meeting environmental regulations (Swamikannu 132).

American government was willing to intervene in car recycling industry in the 1970s, when abandoned cars littered the road. At the moment neither the president nor Congress are anxious to regulate the industry, but if today's recycling problem were to become as unmanageable as it has in other countries, the government would be likely to step in. Now--before we reach crisis point--is the best time to evaluate our legislative options. The laws of other countries can certainly act as a guide. But the laws aren't as generic as they may first appear. Each reflects an underlying attitude about responsibility for the environment. Germany's "take back" laws are based on the "polluter pays principle," which holds that the creator of the final product is responsible for any environmental effects it may have. The laws of Holland are quite different. The Dutch finance the recycling of their cars with a "green fee," a $100 surcharge tacked onto the sticker price of each new car purchased. Manufacturers are also required to increase the recyclability of the cars they produce. They spring from the National Environmental Policy Plan, which is "based on the premise that all of society, not just the government, is responsible for cleaning up the environment (Johnson)." Because each actor in the system, from the steel mill owner to the final owner of a used car, is involved in creating the pollution, each is held to be equally responsible for the solution. The Dutch recycling laws fit this philosophy.

The environmental track record of American industry and American consumers is not impressive. Legislation can make an emerging environmental consciousness legal reality, but their ultimate purpose must first be well thought out. Without a national consciousness or federal policy, automobile recycling will continue to be shaped by the actions of car makers, recyclers, consumers, and local governments. It is up to concerned citizens to make sure the environment and the people who live in it are not forgotten.

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